Modeling Architecture for Technology, Research and EXperimentation

MATREX Overview Brief

Presented at I/ITSEC Conference

1 – 5 December 2008

Chris Bailey / 703.428-6269 / cbailey@d-a-s.com

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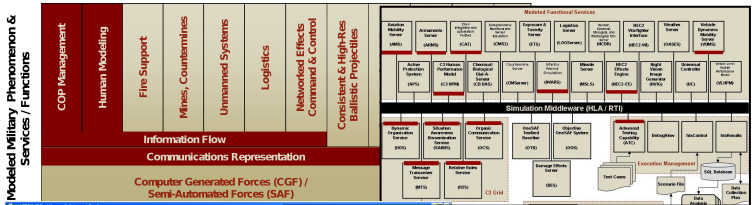
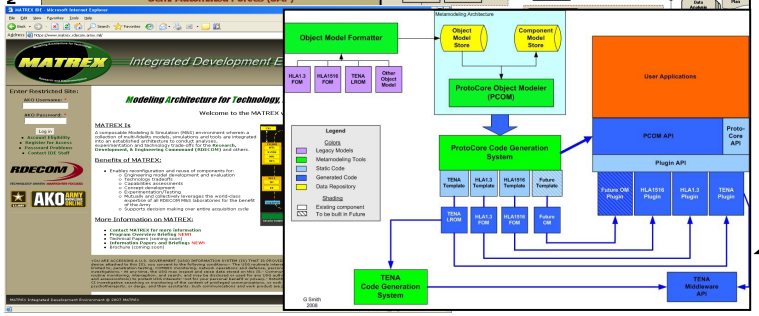
BLUF: MATREX Brings Value to Army M&S Capabilities

- **Provides:**
  - Common integrating SoS Architecture to synchronize M&S across RDECOM Labs & Centers
  - A path for testing and distributing M&S R&D in the M&S Community
  - Collaboration with external M&S communities (TRADOC, ATEC, FCS, JFCOM, etc.)
  - Common Core Simulation Infrastructure and Tools
  - Common Systems Engineering Processes for M&S
  - Distributed / Collaborative enabling services:
    - Web Collaboration (IDE & STEM)
    - Distributed Virtual Lab Services
- **Supports PEOs & PMs with a coordinated & collaborative RDECOM-wide M&S approach**
- **Maximizes interoperability, flexibility & adaptation of RDECOM M&S capabilities to Acquisition Community needs**

MATREX expands RDECOM capabilities to support the Army's mission with M&S

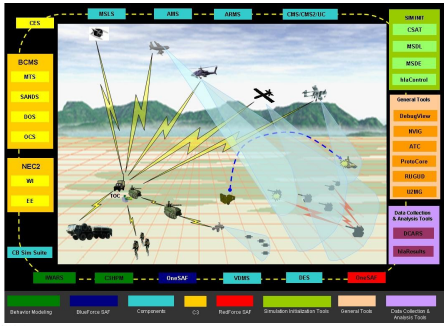
MATREX Overview





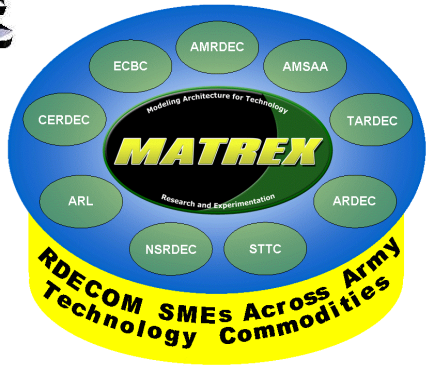
M&S R&D Made Real

Community use informs R&D

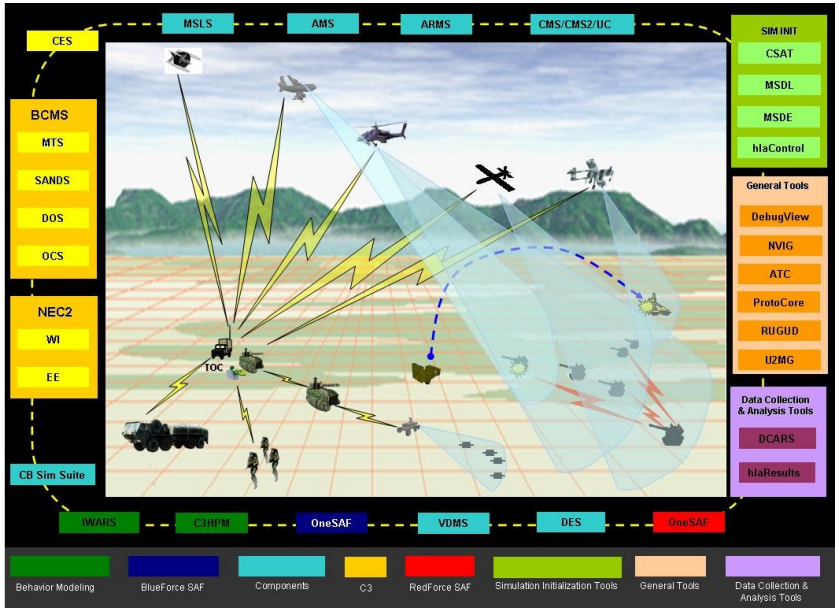


Primary Elements of MATREX

- **Architecture / Environment**
- **Model & Simulations**
- **Tools**
- **Interoperability**
- **Collaboration**



MATREX Purpose



Primary Partners and Customers:

- RDECOM HQ, RDECs, and Labs
- PM FCS (BCT) MSO / FCS LSI
- TRADOC (BLCSE)
- ATEC (OTC)
- 3CE (Cross Command Collaboration Effort)
- Other Army PMs and PEOs

Purpose:

To develop a composable M&S environment wherein a collection of multi-fidelity models, simulations and tools can be integrated, and mapped to an established architecture for conducting analysis, experimentation and technology trade-offs for RDECOM and others.

Benefits:

- Enables reconfiguration and reuse of components for:
  - Engineering model development and evaluation
  - Technology tradeoffs
  - Capabilities assessments
  - Concept development
  - Experimentation
  - Testing
- Mutually and collectively leverages the world-class expertise of all RDECOM M&S laboratories for the benefit of the Army as well as Joint services
- Supports decision making over entire

Critical M&S capabilities necessary to support Network Centric Warfare representation and analysis

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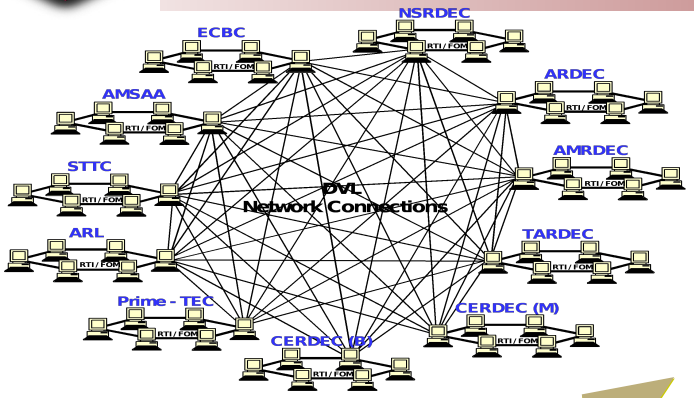
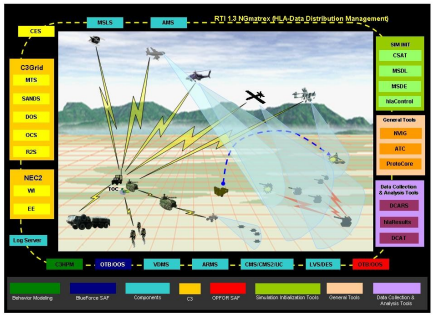
The MATREX Paradigm



MATREX M&S Environment

- Service-Oriented Architecture
- Entity-level COP, distributed SA, with NCW emphasis
- Supports FCS LSI, 3CE, BLCSE, USAOTC, & more



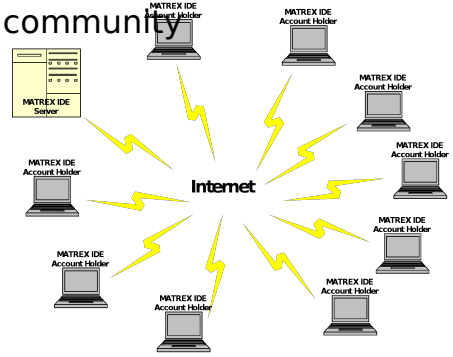
Distributed Virtual Laboratory

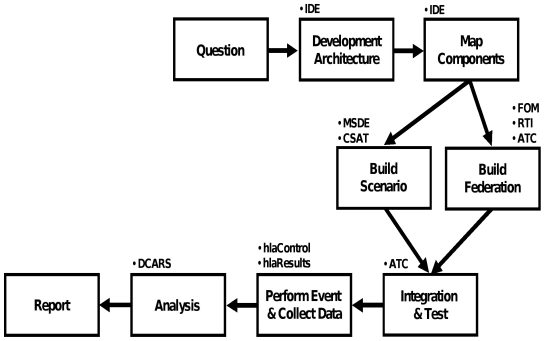
- Network hardware Infrastructure
- Interconnect RDECOM M&S activities
- Connect to 3CE Network (TRADOC BLCSE, ATEC ATIN, FCS LSI)

Robust M&S capabilities from requirements development through integration and test

Integrated Development Environment

- Distributed Systems Engineering
- Requirements and architecture map all the way to the FOM
- Processes and tools
- Collaboration within M&S development and user community

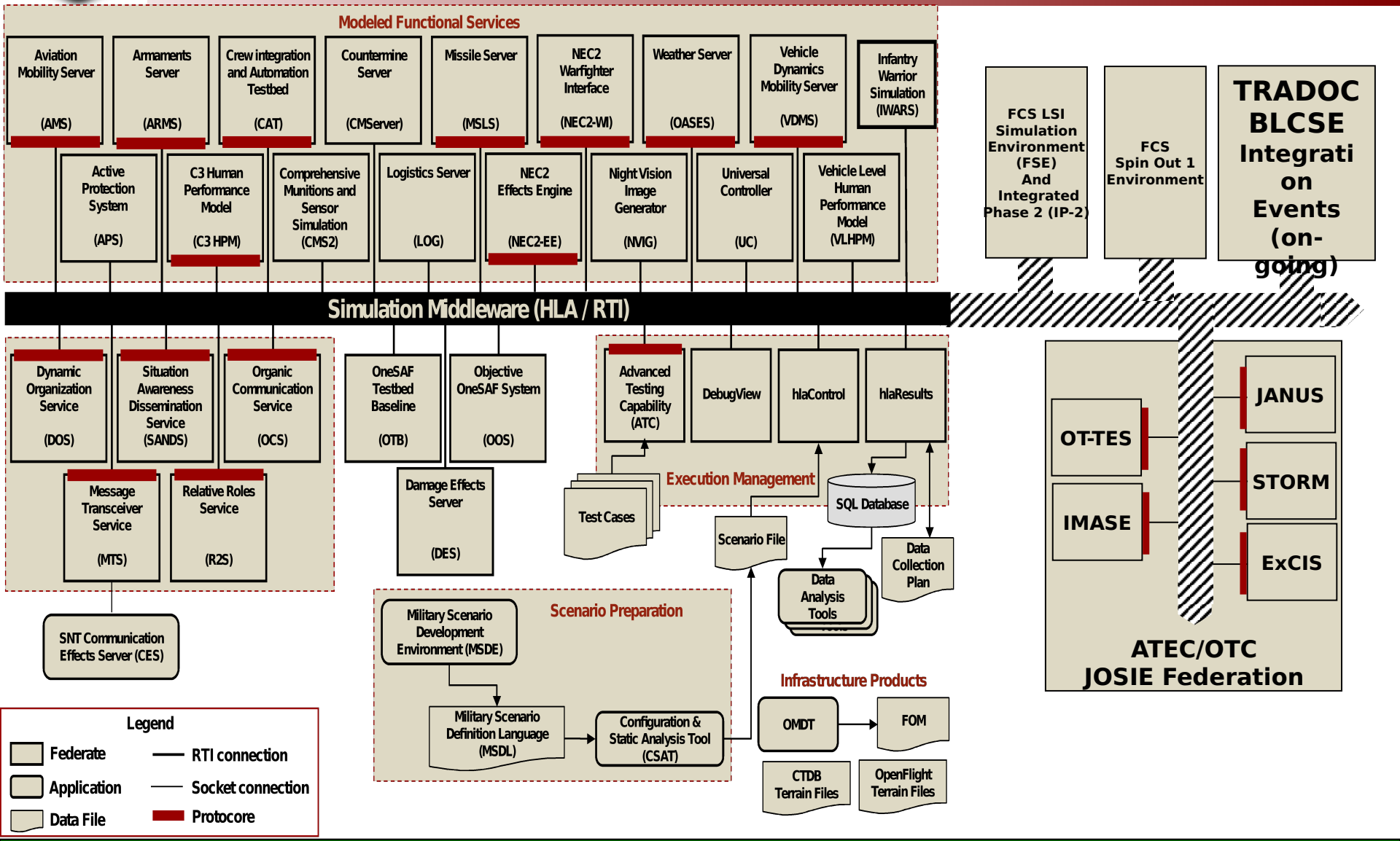




M&S Event Management

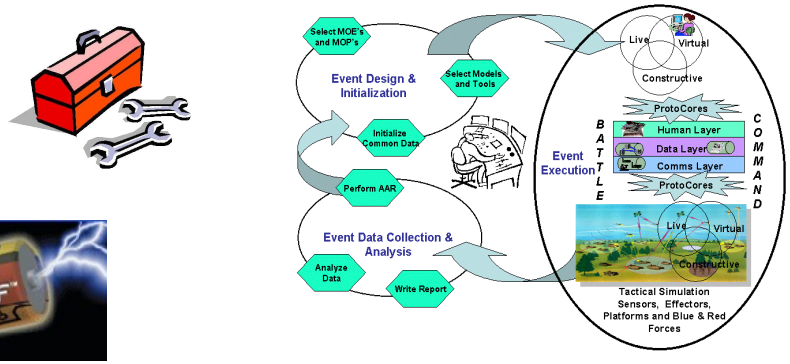
- Foundation for Army M&S events
- Functional system design
- Software integration and test tools
- simulation middleware
- object model

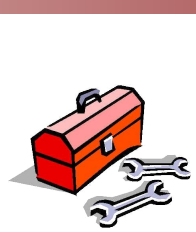
MATREX Building Common Cross-Army Environment



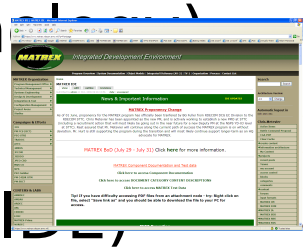
MATREX Provides Many Integrated Capabilities

MATREX Project Areas





- M&S Tools – Usable S&T
- Event Management
- OneSAF Transition
- Human-Centric Enabled Battle Command (HC-NEBC)
- Networked Effects Command & Control (N
- MATREX Middleware Independence Capability (MMIC) (Protocore is the enabling techn
- Distributed Virtual Laboratory (DVL)
- Integrated Development Environment (IDE)
- Verification, Validation, & Accreditation



MATREX Tools Enable a Common Integrated Architecture

Lowers the barrier to entry for utilization of MATREX High-Level Architecture (HLA) and widely used ATEC, RDECOM, and TRADOC M&S and tools

Federation Object Model (FOM) 1. In-common data structures, operations, and communication between federates 2. Describes which HLA services are used, how they are used, & how they are tied to events 3. Co-managed with FCS LSI, providing basis for commonality in FCS M&S community, RDECOM, TRADOC, ATEC, etc.	**Run-Time Infrastructure (RTI)** 1. Enables M&S interoperation over a network, including distributed 2. Embedded functionally to support entity-level analysis 3. Provided as GFX by MATREX, supported by MATREX
ProtoCore 1. M&S interoperability without gateways 2. Provided as GFX by MATREX with support & training available 3. Interoperability includes HLA RTI 1.3NGmatrex, IEEE 1516, & TENA 5.4 (DIS in FY09)	**Distributed Virtual Lab (DVL) network** 1. Securely interconnects RDECOM M&S users/developers via DREN 2. Connected to ATEC, TRADOC, and FCS LSI 3. Maintained by MATREX and the Centers/Labs
Battle Command Management Services (BCMS) 1. Supports entity-level communications and SA dissemination for Battle Command 2. Interconnects comms effects, sensor fusion, human behavior, network, human decision-making, OneSAF, & High-Fidelity M&S 3. Components include MTS, OCS, DOS, SANDS, & R2S	**Integrated Development Environment (IDE)** 1. MATREX distributed engineering and communication capability over Internet 2. Linked and mapped content mgt system for requirements, design, coding, & execution 3. Program Configuration Management mechanism
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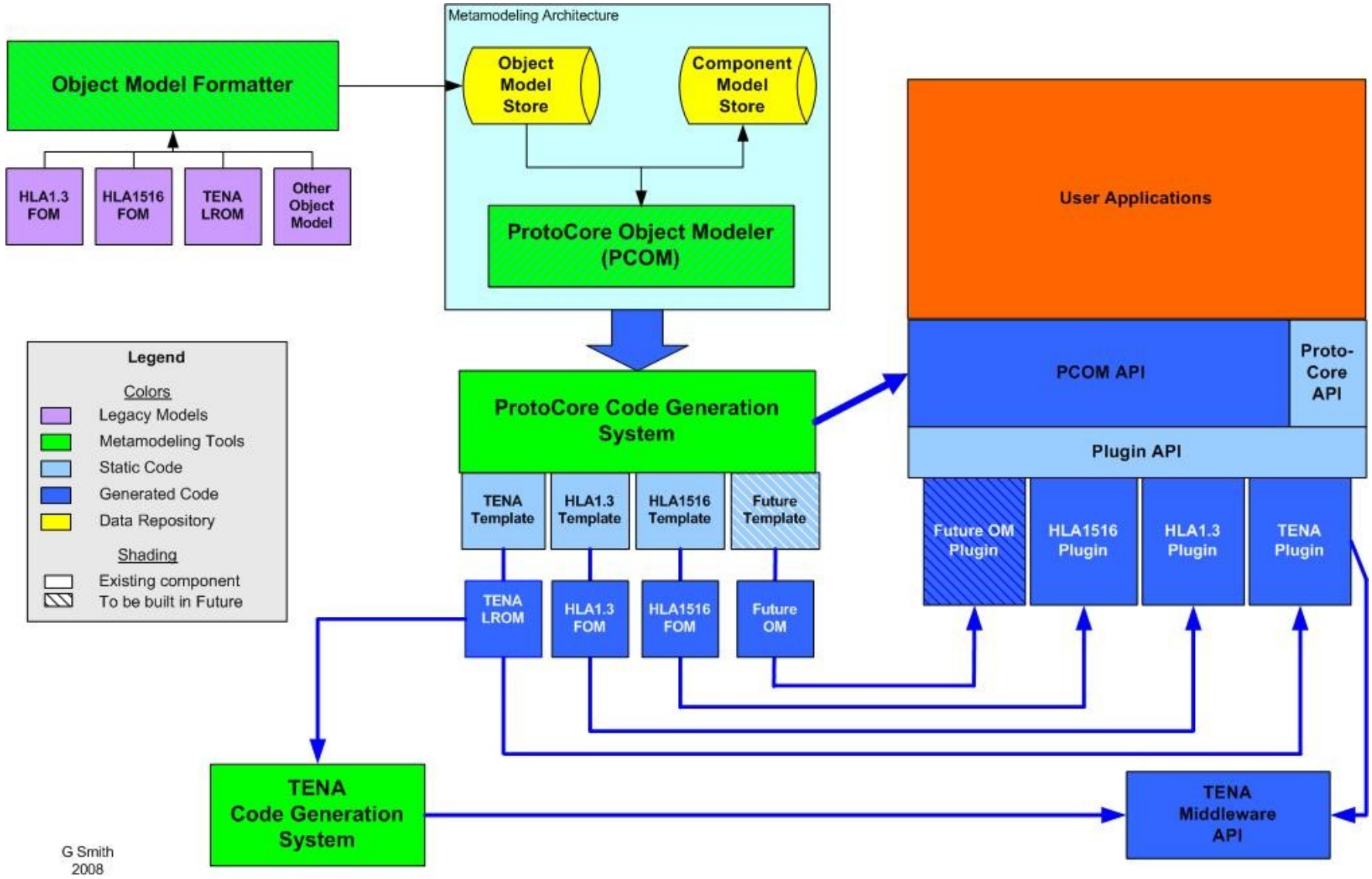
MATREX Middleware Independence Capability (MMIC) ProtoCore – Object Model Architecture



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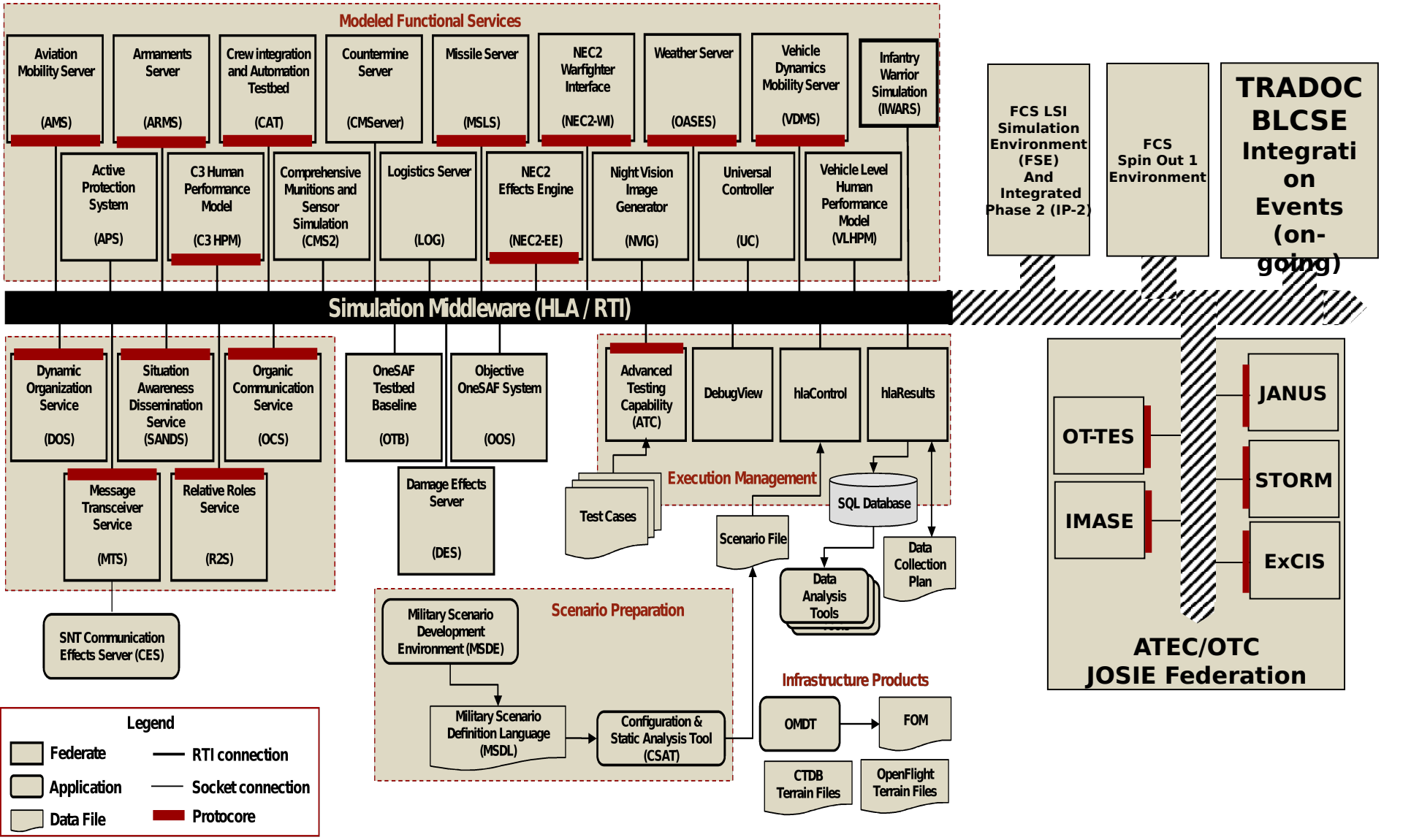

2008 Awards

DoD M&S Award for Test & Eval.

Army M&S Award for Test & Eval.

- *MATREX Partnered with ATEC OTC to assist them in their transition of the OASIS JOSIE components to HLA via the MATREX Protocore*
- *By using ProtoCore, gained 2 types of HLA (1516 & 1.3NG) & also TENA*

EC cost avoidance of approximately $2M and 18 months budget

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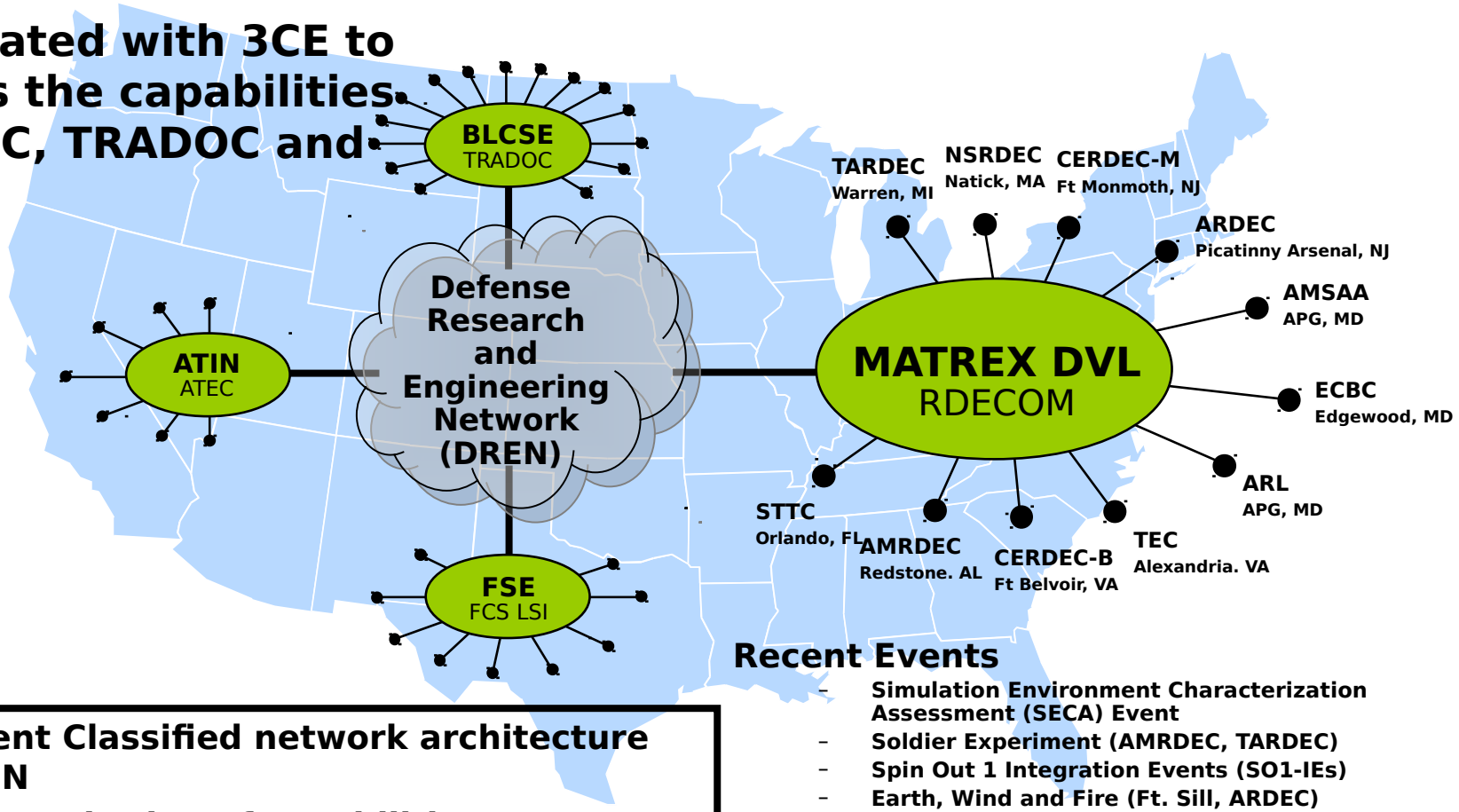
Distributed Virtual Laboratory (DVL)

To Be Connected------

Integrated with 3CE to access the capabilities of ATEC, TRADOC and FCS



- **Persistent Classified network architecture via DREN**
- **Facilitates sharing of capabilities**
- **Collaborative use of RDECOM and Army resources**
- **Analyze requirements as integrated systems of systems**
- **Conduct exercises and events**

Recent Events

- **Simulation Environment Characterization Assessment (SECA) Event**
- **Soldier Experiment (AMRDEC, TARDEC)**
- **Spin Out 1 Integration Events (SO1-IEs)**
- **Earth, Wind and Fire (Ft. Sill, ARDEC)**
- **FCS ACE Service (ARL, TARDEC, ARDEC)**

MATREX IDE

IDE is tailored to M&S Engineering architectural efforts

- Dynamic content creation, maintenance, & modifications that enable all program personnel to contribute knowledge by directly creating & modifying content (with appropriate permissions)
- Enables distributed complex software development, from requirements through Systems Engineering & design to a shared model development environment (future).

Program Management

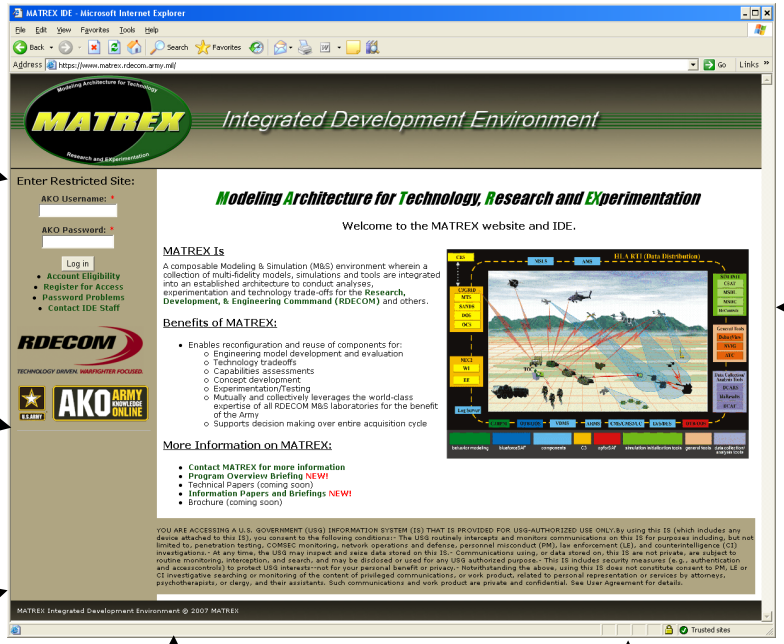
View high level status
View and update schedule documents

Marketing

Educate potential customers and stakeholders
Repository for Army M&S best practices

Operations & Support

Event management concept of operations
Users manual
Technical support interface



Design and Development

View design documentation and link developer documentation
Developer documentation creation / organizing / linking / updating

Integration & Testing

Test cases based on system design for closed-loop product delivery

Systems Engineering

Systems Design

Systems Architecture

Process management
Requirements management
Engineering Document management
Training and education

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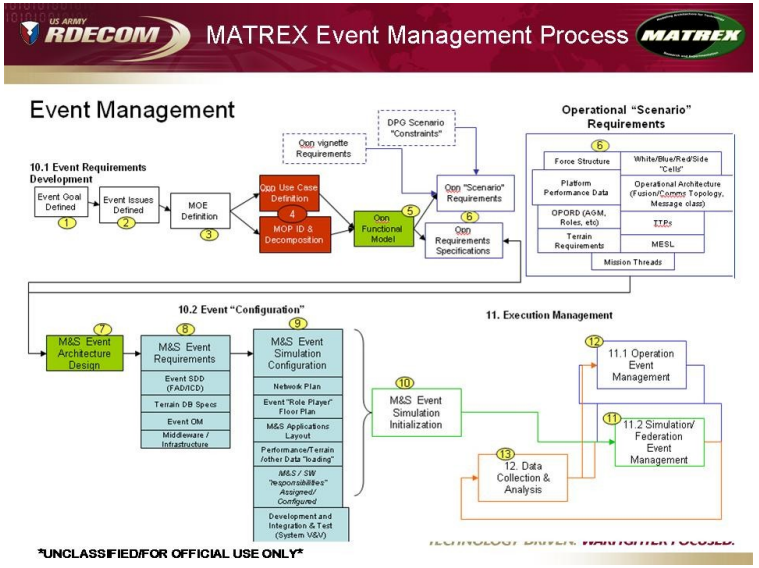
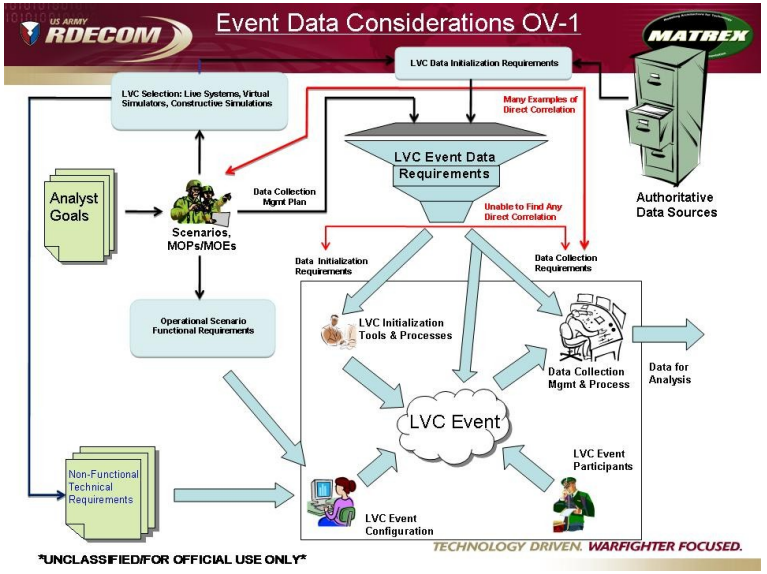
MATREX Event Management

Event Management Includes the Following (And More):

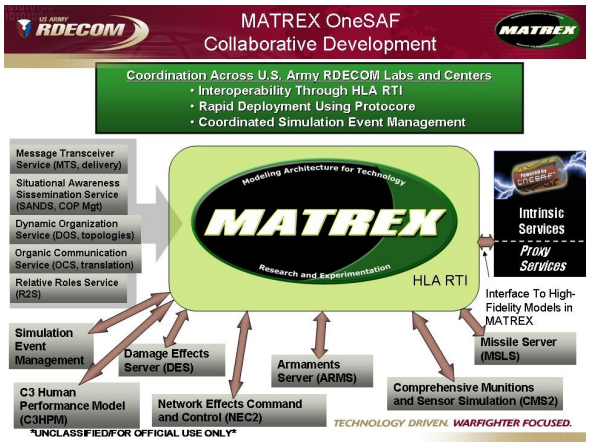
- Development of Event Requirements
- Development of Operational Scenario Requirements
- Design of M&S Event Architecture
- Development of M&S Event Requirements
- Design of M&S Event Simulation Configuration, Including Interface to Live and Virtual Elements
- Simulation to C4I Interoperability
- M&S Event Simulation Initialization
- Simulation/Federation Event Management, Within Context of Overall Event Operation/Execution Management
- Data Collection & Analysis

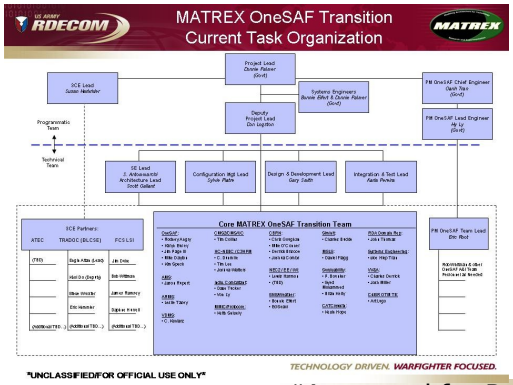




MATREX OneSAF Transition

- MATREX is an Official OneSAF Collaborative Developer
  - FY07 focus was to “swap” OTB out & replace with OneSAF (i.e., maintain same interface functionality with MATREX components).
  - All “Swap” interface work by MATREX completed as planned & delivered to PM OneSAF in “Handover Package” & integrated into baseline.
  - Additional MATREX modifications continue to be developed & rolled-in.
- Developing Cross-RDECOM OneSAF Collaborative Development Team
  - User Training via PM OneSAF
  - Developer Training
    - PM OneSAF Provided
    - MATREX provided & subsidized

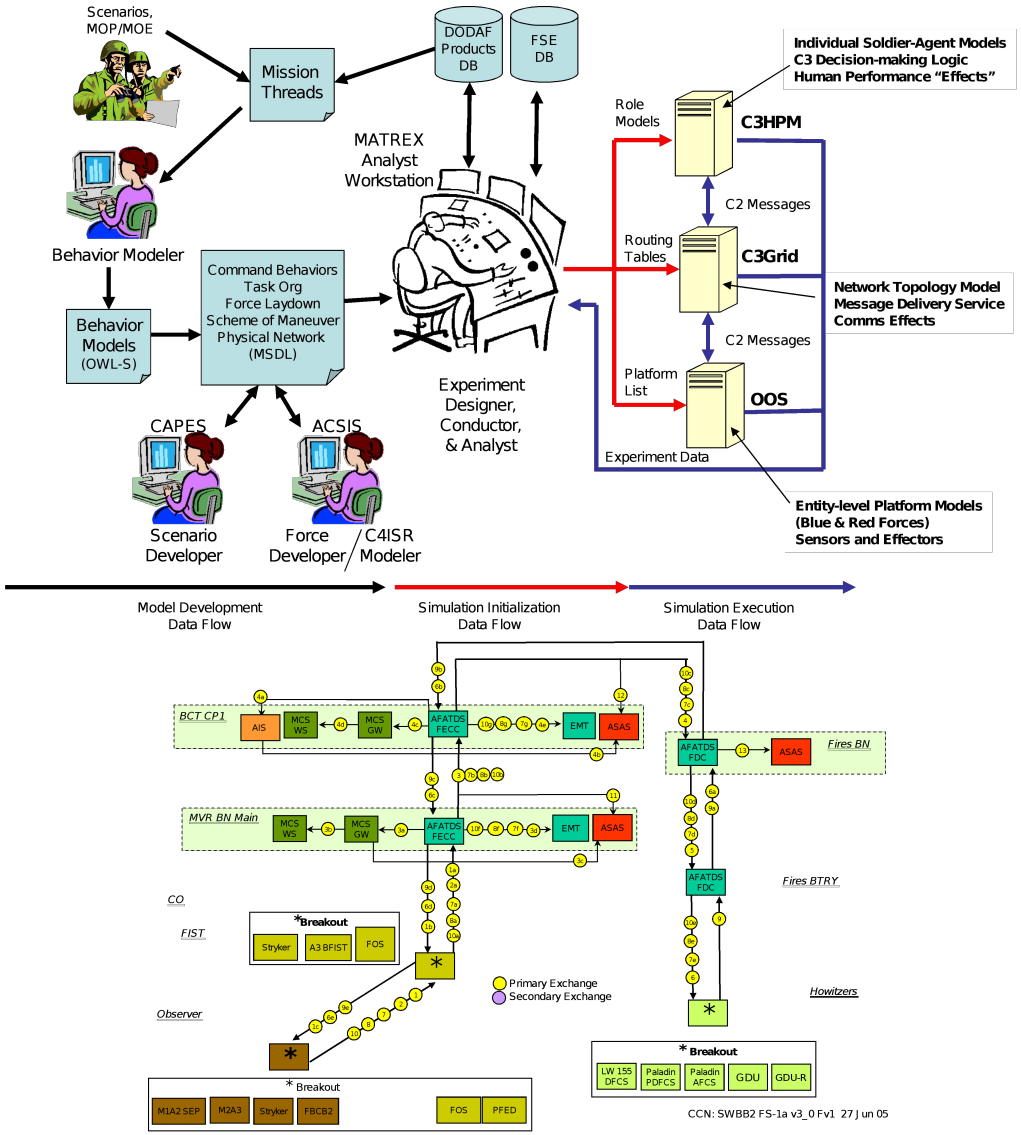

US ARMY RDECOM
MATREX OneSAF
Collaborative Development
MATREX
Coordination Across U.S. Army RDECOM Labs and Centers
• Interoperability Through HLA RTI
• Rapid Deployment Using Protocore
• Coordinated Simulation Event Management
Message Transceiver Service (MTS, delivery)
Situational Awareness Sissemination Service (SANDS, COP Mgt)
Dynamic Organization Service (DOS, topologies)
Organic Communication Service (OCS, translation)
Relative Roles Service (R2S)
Modeling Architecture for Technology
MATREX
Research and Experimentation
HLA RTI
Intrinsic Services
Proxy Services
Interface To High-Fidelity Models in MATREX
Missile Server (MSLS)
Simulation Event Management
Damage Effects Server (DES)
Armaments Server (ARMS)
C3 Human Performance Model (C3HPM)
Network Effects Command and Control (NEC2)
Comprehensive Munitions and Sensor Simulation (CMS2)
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
UNCLASSIFIED/FOR OFFICIAL USE ONLY



Human-Centric Networked-Enabled Battle Command (HC-NEBC)

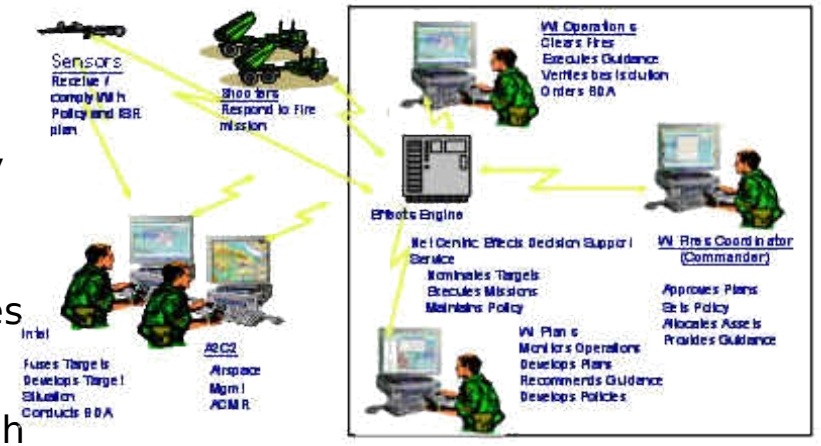
- Models:
  - Information management and C2 tasks to an individual soldier-level fidelity
  - Human decision-making

- Provides:
  - Human "effects" in the form of time and accuracy degradations in situational awareness and decision making
  - Reusable behavior definitions derived from Army Interoperability Certification testing mission threads
  - Analyst interfaces which support force analysis and organizational design issues



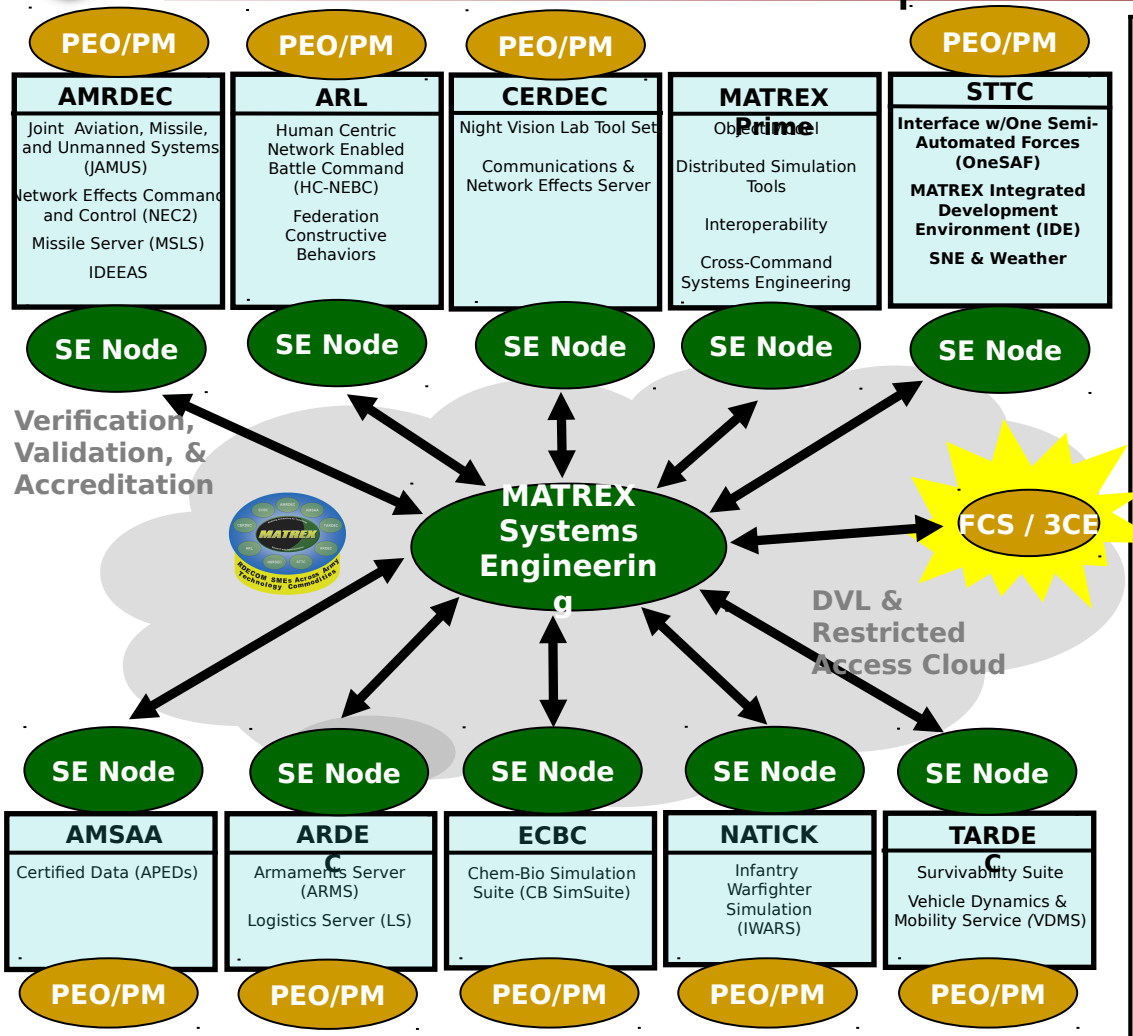
MATREX Network Effects Command and Control (NEC2)

- Overview
  - Networked Fires component of MATREX baseline
  - Enables experimentation to examine the issues of networked effects in a bandwidth constrained environment
- Implementation
  - Combines features of Advanced Field Artillery Tactical Data Systems (AFATDS), two networked fires prototypes (Combat Decision Aid System (CDAS) and ProtoCommand), current Command and Control (C2) prototypes for FCS (MC2), and a communications effects server (BCMS)
  - Centers around an "Effects Engine" (EE) which executes decision support and targeting processes as a network service. Performs target values analysis and attack analysis
- Managing the Network – Key to Success
  - Pairs the tactical requirements of fires control with management of the message flow and network linkages throughout the network
  - Network is managed by policies that are



NEC2 supports experimentation with Networked Effects. MATREX and NEC2 provide a significant toolset to conduct credible Brigade and Below experimentation with critical "tuning knobs" exposed to the war fighter in order to establish minimum network requirements and flesh our workable tactics techniques and procedures.

Systems Engineering for MATREX & RDECOM: Operational View



Integrated M&S System of Systems Engineering (SE) Capability for RDECOM via MATREX:

- **Supporting PEOs and PMs with a coordinated and uniform RDECOM approach**
- **Common integrating SoS Architecture synchronized across RDECOM**
- **Developing SE Nodes for M&S across RDECOM:**
  - Single integrated M&S culture
  - In-Common engineering tools
  - Common requirements database, terminology, and processes
  - Distributed and Collaborative enabling services:
    - Web Collaboration (STEM, IDE, AKO)
    - DVL Services
- **Maximize interoperability, flexibility and adaptation of RDECOM M&S capabilities to the Acquisition Communities needs.**
- **Common OM and Core Capabilities/Tools**

MATREX reduces Technical and Cost Ris programs through coordination

MATREX Collaborations: RDECOM & Beyond

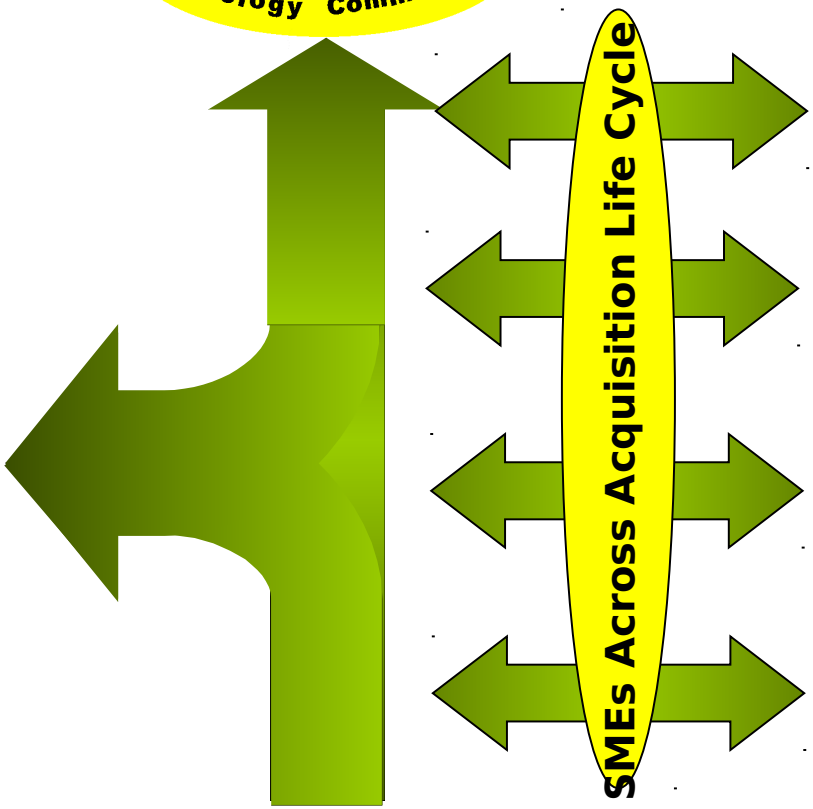
Some of the groups we work w

TRADOC	Mounted Maneuver Battle Lab Air Maneuver Battle Lab Depth & Simultaneous Attack BL Battle Command Battle Lab TRAC Leavenworth TRAC-WSMR
ATEC	IRCC WSMAR HQ USAOTC USAOTC-IEW Electronic PG, Fort Lewis APG Test Center WDTC, Dugway PG RTTC RTTC-RSA
PM	PEO-STRI NLOS-LS PM C4ISR On-The-Move PM FCS (BCT) – FCS LSI PEO Soldier
Other Services	LMC-Orlando (USN) Navy Research Lab Naval Air Warfare Center JTAGSS (USAF)

Note: A full list of groups available upon request.

Fielding of capabilities to provide feedback for R&D direction and decisions

Partners & Collaborati



ATEC (OTC/DTC)
- Test Event Support
- Live Interface
- Sim to C2
- Sim Research

TRADOC
- Analytical Requirements
- BLCSE Conversion to HLA
- FFID Planning
- Sim Infrastructure & Tools

3CE
- Core Planning
- Sim Systems Engineering
- Federation/FOM/Tools
- FCS Spin Out 1
- Sim Infrastructure & Tools

FCS LSI
- FOM
- FCS Simulation Environment (FSE) Collaboration & Development
- GFX Delivery, Training & Support

Primary MATREX Campaigns

- **Future Combat Systems (PM FCS BCT MSO & FCS LSI)**
- **Cross-Command Collaboration Effort (3CE)**
- **Mounted Maneuver Battle Lab (MMBL), Ft. Knox, KY**
- **Battle Lab Collaborative Simulation Environment (BLCSE)**
- **ATEC Operational Test Command (OTC)**
- **PM Stryker Brigade Combat Team (SBCT)**
- **Joint Forces Command (JFCOM)**
- **Joint Improvised Explosive Devices Defeat Office (JIEDDO)**
- **JPEO Chemical Biological Defense (CBD)**
- **M&S Coordination Office (MSCO)**
- **Naval Postgraduate School (NPS)**
- **PEO Soldier**
- **Joint Aviation Manned & Unmanned Systems (JAMUS)**
- **PM C4ISR On The Move (OTM)**

Event support is customer funded

MATREX Summary

- **MATREX exists to provide integrated RDECOM-wide M&S capabilities to help reduce technical, cost, and schedule risk**
  - **Reduces duplicative M&S efforts**
  - **Reuses current M&S models and tools in new ways with new customers**
  - **Fosters collaboration - ongoing active dialogue among the labs**
- **MATREX is also working with TRADOC, ATEC, PM FCS(BCT) / FCS LSI, and 3CE to build an Army solution for M&S experimentation applicable across the acquisition life cycle**
  - **Ensures interoperability and composability across Army M&S capabilities**
  - **Enables more integrated and collaborative analysis so PMs can ensure that all parts of their R&D investment work together across the acquisition lifecycle**
- **Supports M&S design, development, test, integration, and applications**
  - **Core program is focused on architecture, processes and tools**
  - **Processes involve all elements of RDECOM**
- **MATREX architecture, processes, tools and models are maturing to support NCW modeling and analysis in a distributed environment**
  - **Provides unique capability to model both information & decision making**

MATREX is a tool available for *your* use

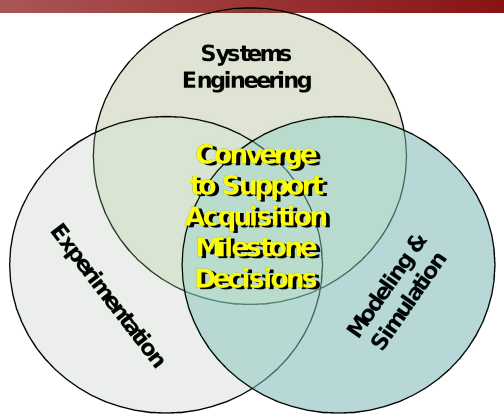
Acronyms

- 3CE – Cross-Command Collaborative Effort
- ACS – Aerial Common Sensor
- AKO – Army Knowledge On-Line
- ALCES - Aggregate Level Communications Effects Service
- AMS – Aviation Mobility Service
- AMSWG – (OSD) Acquisition Modeling & Simulation Working Group
- ARMS – Armaments Service
- ATC – Automated Test Capability
- ATEC – Army Test and Evaluation Command
- ATIN – ATEC Test Integration Network
- AUTL – Army Universal Task List
- BCMS – Battle Command Management System
- BCT – Brigade Combat Team
- BLCSE – Battle Lab Collaborative Simulation Environment
- C3HPM – Command, Control, & Communications Human Performance Model
- CES – Communications Effects Server
- CMS – Countermine Server
- CMS2 – Comprehensive Munitions & Sensor Server
- CSAT – Configuration and System Administration Tool
- C4ISR – Command & Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
- DCARS – Data Collection, Analysis & Reporting System
- DCA – Data Collection & Analysis
- DCAT – Data Collection & Analysis Tool
- DES – Damage Effects Server
- DOTMLPF – Doctrine, Organization, Training, Materiel, Leadership, Personnel & Facilities
- DOS – Dynamic Organization Service
- DTC – Developmental Test Command
- DTE – Distributed Test Event
- DT&E – Developmental Test and Evaluation
- DVL – Distributed Virtual Laboratory
- EE – Effects Engine
- FCS – Future Combat Systems
- FOC – Full Operational Capability
- FOM – Federation Object Model
- FRP – Full Rate Production
- FSE – FCS Simulation Environment
- HLA - RTI – High Level Architecture – Run Time Interface
- HC-NEBC – Human Centric – Network Enabled Battle Command
- HPM – Human Performance Model
- IDE – Integrated Development Environment
- IOC – Initial Operational Capability
- IOT&E – Initial Operational Test and Evaluation
- IER – Information Exchange Requirement
- IP03 – Integrated Process 03, Networked Fires
- IPT – Integrated Process Team
- IWARS/DI – Infantry Warrior Simulation/Dismounted Infantry
- JCAS – Joint Close Air Support
- JCIDS – Joint Combat Integrated Defense System
- JROC – Joint Requirements Oversight Council
- JSBE – Joint Service Battlespace Environment
- KPP – Key Performance Parameters
- LSI – Lead Systems Integrator (FCS)
- LVC – Live Virtual Constructive
- LVCI - Live Virtual Constructive Interoperability
- LVS – Lethality/Vulnerability Service
- MATREX – Modeling Architecture for Technology, Research, & EXperimentation
- MC2 – Mobile Command & Control
- MDA – Model Driven Architecture
- MMIC – MATREX Middleware Independence Capability
- MOE – Measures of Effectiveness
- MOP – Measures of Performance
- M&S – Modeling and Simulation
- MSDE – Military Scenario Development Environment
- MSDL – Military Scenario Definition Language
- MSLS – Missile Service
- MSO – PM FCS (BCT) Modeling & Simulation Office
- MTS – Message Transceiver Service NCW – Network Centric Warfare
- NEC2 – Networked Effects Command & Control
- NVIG – Night Vision Image Generator
- OCS – Organic Communications Service
- OneSAF – One Semi-Automated Forces
- OOS – OneSAF Objective System
- OTB – OneSAF Testbed Baseline
- OTC – Operational Test Command
- PEO – Program Executive Office
- PM – Product, or Program or Project Manager
- R2S – Relative Roles Server
- RDECOM – Research, Development, & Engineering Command
- RDEC – Research, Development & Engineering Center
- S3E – Systems Engineering, Experimentation, and Enterprise
- SANDS – Situational Awareness Normalization & Dissemination Service
- SE – Systems Engineering
- Sim Init – Simulation Initialization
- SNE – Synthetic Natural Environment
- SoS – System of System
- SoSE – System of System Engineering
- SOSCOE – System of Systems Common Operating Environment
- STEM – Science and Technology Enterprise Management
- S&T – Science and Technology
- TENA – Test & Training Enabling Architecture
- TIE – Technical Integration Event
- TRADOC – Training & Doctrine Command
- UAV – Unmanned Aerial Vehicle
- UC – Universal Controller
- UJTL – Universal Joint Task List
- USAF – United States Air Force
- USMC – United States Marine Corps
- VDMS – Vehicle Dynamics & Mobility Service
- V&V – Verification and Validation
- VV&A – Verification, Validation & Accreditation
- WECM – Warfighter Electronic Collection and Mapping
- WI – Warfighter Interface

BACK-UP SLIDES

MATREX Supports Entire Acquisition Life Cycle

Enable cross-commodity M&S tools, capabilities, processes and people to support technology development, systems integration and product [illegible]nt across the acquisition life



PM and other user Technology Opportunities

Supporting Systems Engineering and Experimentation across the Acquisition Life Cycle

JCIDS

JROC

A B C IOC FOC

Concept Refinement | Technology Development | System Development & Demonstration | Production & Deployment | Operations & Support

Pre-Systems Acquisition | Systems Acquisition | Sustainment

Concept Dev | System Design | System Dev | DT&E | IOT&E | Operations

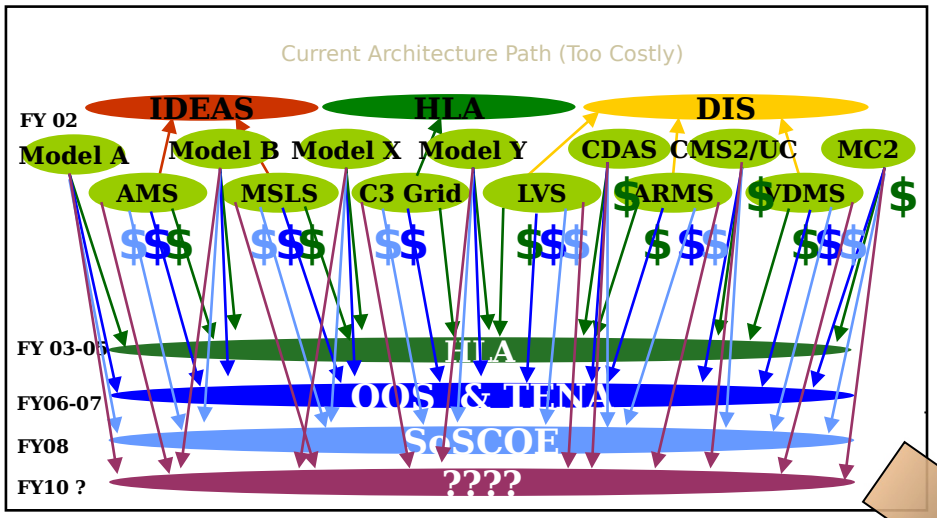
Joint Environment: Constructive → Virtual → Live

MATREX L-V-C Capability Integrators

MATREX Core Products: Process & Procedures; Data; Toolbox

Reduce expense of "Live" activities

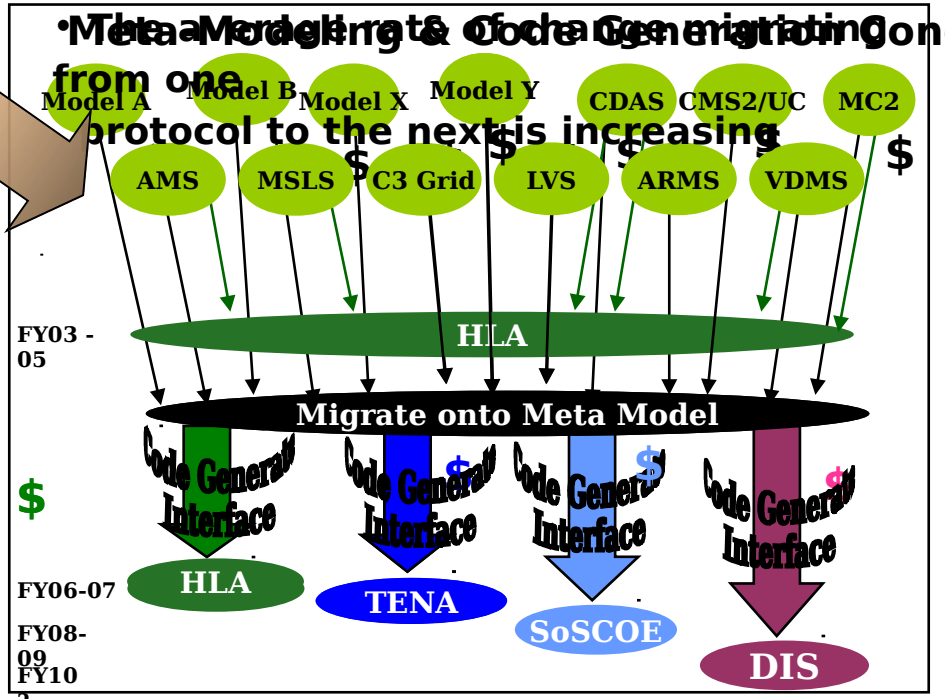
MATREX Enables M&S Seamless Interoperability



M&S Interoperability Problem Space

- The Army spends millions of dollars per year
  migrating Models and Simulations between
  various protocols and building gateways
- The Army's rate of change is increasing

Meta-Modeling & Code Generation Concept



Results

- In use at RDECOM M&S activities
- In use at OTC with JOSIE+1 federation
- In use at FCS LSI at Huntington Beach FSE
- In use at Spin Out 1 events
- Planned for Stryker and other PMs in CY 2008
- Demonstrated at 2006 and 2008 DoD M&S Conference

FY08 MATREX Projects (1/2)

Activity	Description
Network Centric Warfare	M&S supporting entity-level analysis/experimentation capabilities of Battle Command
Distributed Virtual Laboratory (DVL)	RDECOM network supporting distributed simulation, simulation events, interoperability with ATEC, TRADOC, FCS LSI
Event Management	Sim Init, DCRA, Analysis, Data, SE, tools, and processes, cross-command collaborative development, 3CE Sim Init IPT lead, Data Management IPT participant
VV&A	Independent assessment and update of MATREX/RDECOM M&S products
RDECOM	MATREX tools, processes, integrated RDEC federates, SE processes, IPT support, DVL, integrated PEO/PM support
3CE	3CE Core Planning, collaborative requirements development, host or support IPTs, SO1 Support for HLA and MATREX FOM
FCS LSI	Integrate Armaments Server, Missile Server, MATREX HLA, FOM, tools, collaborative architecture and environment development
ATEC OTC	Transition JOSIE+1 USAOTC federation from DIS to MATREX HLA using ProtoCore, training, support, develop L-V-C interoperability

FY08 MATREX Projects (2/2)

Activity	Description
TRADOC BLCSE (MMBL)	Supporting installation of MATREX HLA, tools (inc SA dissemination), and federates at MMBL, proof of process prior to engaging other battle labs
C4ISR On-The-Move Testbed	Phase 1: Transition to MATREX HLA and tools; Phase 2: Support MATREX community with MATREX/Testbed interoperability
PEO GCS (PM Stryker)	Phase 1: MATREX RTI, FOM, tools; Phase 2: MATREX/RDECOM/USAOTC interoperation supporting embedded training with M&S wrap-around
PEO Soldier	Supporting transition to MATREX HLA and tools
OneSAF	Dross-community collaborative SAF capability development, integration into MATREX environment
CB Sim Suite	Integrate the CB Sim Suite with entity-level MATREX architecture and environment to support high-resolution CBRN analysis (SO-2 rqt and more)
Sensor Fusion	Level 1 sensor fusion algorithm integrated with Organic Communication Service in MATREX environment
Human Performance	Model the decision-making of individual combatant for Battle Command
Comms and Network Effects	Integrate SNT CES, other CES, requirements from FCS LSI and 3CE
Event Participation	JAMUS: Transition AMRDEC M&S to MATREX HLA, tools,